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Attenuation and scattering tomography of the deep plumbing system of Mount St. Helens

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We present a combined 3D *P*-wave attenuation, 2D *S*-coda attenuation, and 3D *S*-coda scattering tomography model of magmatic/fluid chambers, feeding systems, and sediments below Mount St. Helens (MSH) volcano between depths of 0 and 18 km. High scattering and high attenuation shallow anomalies are indicative of magma and fluid cumulates within and below the volcanic edifice down to 6 km depth. These structures induce a combination of resonant-scattering and strong attenuation on any seismic wave-field recorded north and east of the volcanic cone. North of the cone between depths of 0 and 10 km a low-velocity, high-scattering, and high-attenuation north-south trending trough is attributed to thick piles of Tertiary marine sediments inferred to lie within the Saint Helens Seismic Zone (SHZ). A laterally-extended 3D scattering contrast at depths of 10 to 14 km is related to the boundary between upper and lower crust, and caused in our interpretation by the large scale interaction of the Siletz terrane with the Cascade arc crust. This contrast presents a low scattering, 4-6 km^2 "hole" under the north-eastern flank of the volcano: we infer that this section represents the main path of magma ascent from depths larger than 6 km at MSH. The images suggest a small north-east shift in the lower plumbing system of the volcano as well as the absence of any large melt sill extending between depths of 0 and 18 km. We conclude that combinations of different non-standard tomographic methods, and particularly the application of full-waveform tomography to highly heterogeneous media, represent the future of seismic volcano imaging.